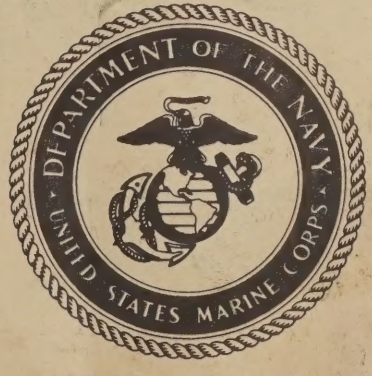
TM-04531A-15
NAVELEX 0967-387-2010

U. S. MARINE CORPS TECHNICAL MANUAL

BATTERY CHARGER
PP-6241/U

FSN 6130-106-6445

OPERATION AND MAINTENANCE



JULY 1970

DEPARTMENT OF THE NAVY
Headquarters, U.S. Marine Corps
Washington, D.C. 20380

31 July 1970

1. This Manual, which supersedes and cancels TM-04531A-15 (INTERIM) in its entirety, is effective upon receipt, and provides instructions on the operation and maintenance of Battery Charger, PP-6241/U (FSN 6130-106-6445).

2. Notice of discrepancies and suggested changes to this Manual should be forwarded to the Commandant of the Marine Corps (Code CSY).

BY DIRECTION OF THE COMMANDANT OF THE MARINE CORPS

OFFICIAL

L. H. BOSSHARD
Colonel, U.S. Marine Corps
Director, Technical Division
Supply Department

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RECORD OF CHANGES

CHANGE NO.	DATE ENTERED	TITLE OR BRIEF DESCRIPTION	ENTERED BY (SIG - RANK)

SAFETY SUMMARY

LISTED BELOW IS EVERY "WARNING" CONTAINED IN THIS MANUAL AND THE PAGE ON WHICH THE "WARNING" IS LOCATED. ALL PERSONNEL INVOLVED IN THE OPERATION AND MAINTENANCE OF THIS EQUIPMENT MUST FULLY UNDERSTAND THE "WARNING" AND THE PROCEDURE BY WHICH THE HAZARD IS TO BE REDUCED OR ELIMINATED. PERSONNEL SHALL BECOME THOROUGHLY FAMILIAR WITH ALL ASPECTS OF SAFETY OF PERSONNEL AND EQUIPMENT PRIOR TO THE OPERATION AND MAINTENANCE OF THE EQUIPMENT.

1. Dangerous voltages are exposed with the case bottom removed. Caution should be exercised to avoid injury. (Page 5-2.)

2. Dangerous voltages are exposed with the case bottom removed. Caution should be exercised to avoid injury. (Page 5-7.)

3. Dangerous voltages are exposed with the case bottom removed. Caution should be exercised to avoid injury. (Page 5-11.)

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Figure 1-0. Battery Charger, PP-6241/U

SECTION 1

GENERAL INFORMATION

1-1. SCOPE. This manual is effective upon receipt and supersedes TM-04531A-15 (INTERIM). It provides instructions for first through fifth echelons of operation and/or maintenance of Battery Charger, PP-6241/U.

1-2. GENERAL DESCRIPTION. The PP-6241/U is a portable, three-channel battery charger that contains precision solid-state electronic controls. It was developed to meet military requirements for charging silver-zinc batteries such as the BB-451/U. The equipment is designed with digitally dialable cutoff voltage programmable from the front panel in 0.1-volt steps from 0.0 to 36.0 volts. Dialable cutoff voltage extends the capabilities of the battery charger so that it may charge silver-cadmium and lead-acid batteries in addition to silver-zinc batteries.

1-3. PHYSICAL DESCRIPTION. The battery charger, housed in a watertight field case, includes one input power cable, three general purpose charging cables, three BB-451/U charging cables, and one instruction manual. The case's detachable cover provides storage space for the accessories.

1-4. REFERENCE DATA

Channel Specifications:

Number of Channels:	Three functionally independent channels.
Current:	
Range:	Selectable at 1.0 or 2.25 amperes.
Accuracy:	± 5% independent of battery voltage.
Cutoff Voltage:	
Silver-Zinc Range:	8, 16, or 32 volts.
Accuracy:	± 1% derated ± 1% at temperature extremes.
Dialable Range:	Digitally dialable in 0.1-volt steps from 0.0 to 36.0 volts.
Accuracy:	± 2% of value dialed from 1.0 to 36.0 volts.
Output Current Waveform:	RMP to average ratio (form factor) less than 1.25:1.

Unit Specifications:

Power Source:	105 to 132 volts AC, 50 to 400 Hertz, single phase.
Input Current:	4 amperes.
Accuracy:	Stated accuracies are over an ambient temperature range of 15°C. to 35°C. Cutoff voltage measured at the charger assembly terminals. Usable with a slight reduction in accuracy from 0°C. to 65°C.

Physical Specifications:

Overall Dimensions:	13.8" W., 11" H., 12.3" D.
Weight:	Net 37.3 pounds.
Case:	Watertight field case. Detachable cover with accessory storage.

1-5. EQUIPMENT SUPPLIED. A list of the equipment supplied with the battery charger is found in table 1-1, following:

TABLE 1-1. EQUIPMENT SUPPLIED

QTY PER EQUIP	NOMENCLATURE NAME	DESIGNATION	OVERALL DIMENSIONS (HEIGHT)	(WIDTH)	(DEPTH)	VOLUME (CU.FT.)	WT. (LB.)
1	Battery Charger	PP-6241/U	11 in.	13.8 in.	12.3 in.	1.0	33
1	Cable Assembly Power, Electrical	CX-11971/U		96 in. long			1.1
3	Cable Assembly Power, Electrical	CX-11792/U		18 in. long			1.0
3	Cable Assembly Power, Electrical	CX-11964/U		18 in. long			2.0
1	Instruction Manual for Battery Charger PP-6241/U		10.75 in.	8.25 in.	0.25 in.		0.25

1-6. EQUIPMENT REQUIRED BUT NOT SUPPLIED. All items of equipment required but not supplied are utilized in calibration procedures for the battery charger. The list of the required calibration instruments is found in table 5-1.

SECTION 2

INSTALLATION

2-1. GENERAL. The battery charger is completely portable and does not require any permanent installation site. Figure 2-1 shows the dimensional data required for space allocation for operation or storage of the battery charger.

2-2. POWER REQUIREMENTS. The battery charger requires a power source of 105 to 132 volts AC, 50 to 400 Hertz, single phase.

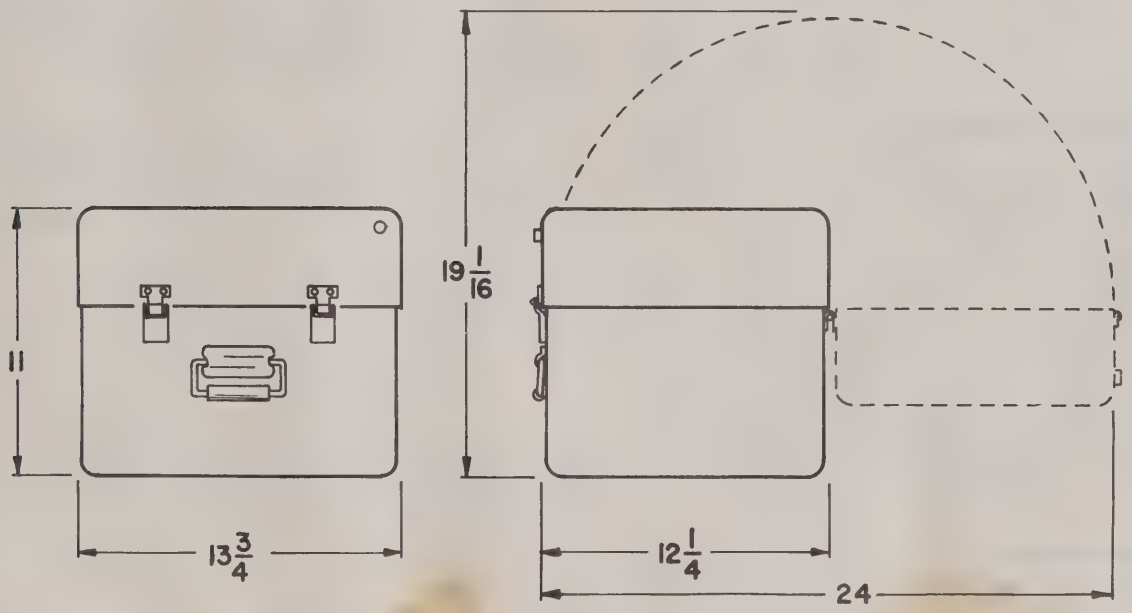
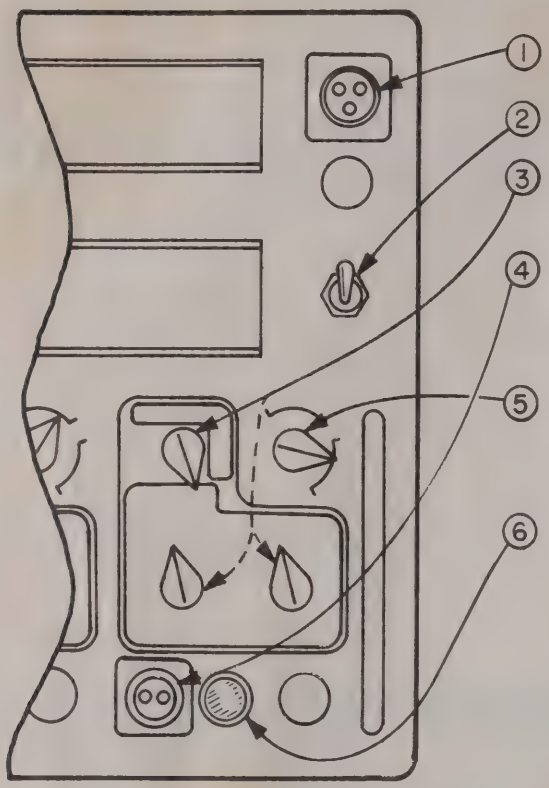


Figure 2-1. Outline: Battery Charger, PP-6241/U

CONDENSED OPERATING INSTRUCTIONS



1. CONNECT INPUT POWER CABLE.
2. TURN POWER ON.
3. SELECT DESIRED CUTOFF VOLTAGE.
4. CONNECT CHARGING CABLE TO CHARGER AND BATTERY (OBSERVE CORRECT POLARITIES).
5. START AT DESIRED CHARGE CURRENT (IN START POSITION, LAMP IS ON FOR CHECK BUT NO CURRENT FLOWS).
6. CHARGING LAMP WILL TURN OFF WHEN CHARGE IS COMPLETE.

CAUTION

DO NOT DISCONNECT A BATTERY FROM THE CHARGER WHILE THE CHARGING LAMP IS ON.

SECTION 3

OPERATION

3-1. FUNCTIONAL OPERATION. The battery charger contains three independent charging channels which may be utilized individually or in combination. When operating, each channel can charge a battery at either 1.0 ampere or 2.25 amperes. The charge will be terminated when the battery voltage has risen to any preset cutoff voltage to 36.0 volts.

3-2. OPERATING PROCEDURES.

a. Operator Controls and Indicators. Locations of the operator controls and indicators are shown in figure 3-1. Table 3-1 provides information on the function of each of the controls and indicators. It should be remembered that the battery charger has three identical charging channels and that controls and indicators numbered 4 through 10, though shown for only one channel, pertain to all three channels.

b. Sequence of Operation: Preliminary Operations. Before charging batteries, it is necessary to perform the following operations:

(1) Connect the battery charger to a source of AC power (105 to 132 volts AC, 50 to 400 Hertz, single phase).

(2) Set the POWER/ON switch to ON.

NOTE

If the charger has been transported by air prior to use, the case may be difficult to open due to a relative vacuum inside the case. To remedy this, open the pressure relief valve on the front of the battery charger.

TABLE 3-1. FUNCTIONS OF OPERATOR CONTROLS AND INDICATORS

NO.	CONTROL/INDICATOR	FUNCTION
1	Power Cable Connector	Connector for the input power cable.
2	Input Fuse	Fuse in the input power line.
3	POWER/ON Switch	Activates the input power circuit and the power supply board.
4	CHARGE CURRENT Selector Switch	Selects charge current (1.0 or 2.25 amperes) supplied by the channel. When set to START, closes the lamp circuit for lamp check. When released from START, initiates the charge at the selected rate.
5	Range Switch	Selects either a present charge cutoff voltage for silver-zinc batteries (8, 16, or 32 volts) on the SILVER-ZINC range, or the tens digit of the adjustable cutoff voltage setting on the ADJUSTABLE range.
6	Unit Volts Selector Switch	Select the units digit of the voltage cutoff setting when the range switch is in the ADJUSTABLE range.
7	Tenth Volts Selector Switch	Selects the tenths digit of the voltage cutoff setting when the range switch is in the ADJUSTABLE range.
8	Charging Cable Connector	Provides connection to the battery being charged through a charging cable.
9	Output Fuse	Fuse in the channel output ciruit.
10	CHARGING Lamp	When illuminated, indicates that charge current is flowing.

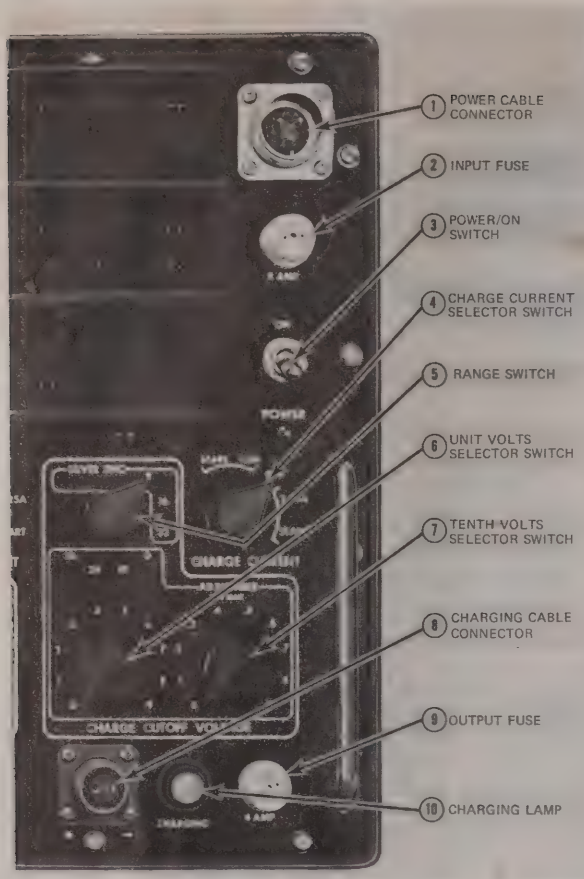


Figure 3-1. Operator Control and Indicator Locations

c. Sequence of Operation: Silver-Zinc Batteries. To charge a silver-zinc battery, perform the following operations:

(1) Select a channel and set the range switch to the desired silver-zinc cutoff voltage (8, 16, or 32 volts for a 6-, 12-, or 24-volt nominal silver-zinc battery).

(2) Connect a charging cable from the selected channel to the battery. Observe correct polarity.

NOTE

Special charging cable assemblies are supplied for use with type BB-451/U Silver-Zinc Batteries.

(3) Start the channel at the desired charge current. Observe that the CHARGING lamp turns on when the CHARGE CURRENT selector switch is in the START position.

NOTE

If the charging lamp does not stay on after the start action:

(1) The Silver-Zinc Battery is either in a harmfully discharged state or shorted, (2) the battery is at or above the selected cutoff voltage, (3) the charging connector has not been connected to the battery properly, or (4) the channel fuse is burned out. Refer to the special charging techniques in paragraph 3-2d. To manually stop the current while the battery is charging, turn the charge current selector switch to off.

(4) As the battery charges, its terminal voltage will rise. Upon reaching the full-charge cutoff voltage, the channel will automatically stop charging and the CHARGING lamp will turn off.

NOTE

The battery will, by its nature, decrease in voltage when the charging current stops.

d. Special Charging Techniques for Silver-Zinc Batteries. Effects may occasionally occur in silver-zinc batteries that will require special charging techniques. These techniques are to be employed only when the charge does not start by the operations in paragraph 3-2c. Perform the following operations:

(1) Place a precision voltmeter, selected from those listed in table 5-1, to monitor the voltage on the battery terminals at the battery charging connector.

(2) Select 36.0 volts cutoff voltage on the charging channel.

(3) Start the channel at the desired current rate.

(4) Observe the on-charge battery voltage. If the battery voltage rises to or above the proper cutoff voltage (8, 16, or 32 volts for 6-, 12-, or 24-volt nominal silver-zinc batteries) and remains at that level for more than 2 minutes, the battery has already attained its full charge and is ready for use, or there is excessive resistance in the cell interconnections. Refer to the battery maintenance manual for maintenance of the cell interconnections.

(5) If the CHARGING lamp does not remain lighted when the channel is started, the cell interconnections may have excessive resistance and battery maintenance is needed. Refer to the battery maintenance manual.

(6) If the on-charge battery voltage rises and then stabilizes to a voltage of near 7.80, 15.60, or 31.20

volts (for 6-, 12-, and 24-volt nominal-zinc batteries) within 2 minutes, there has been a clearing of the "surface charge effect" of the silver-zinc battery. Turn the start switch to OFF. Return the range switch to the proper silver-zinc cutoff voltage and restart the channel. The charger will then continue to operate as described in paragraph 3-2c(4).

(7) If the on-charge battery voltage does not rise to approximately 6, 12, or 24 volts (for 6-, 12-, and 24-volt nominal batteries) within 2 minutes, the battery either may have been very severely discharged or has significant internal or external current leakages. Discontinue charge. Refer to the battery maintenance manual.

e. Sequence of Operation: Batteries of Other Types Than Silver-Zinc. The battery charger may be used to charge batteries of other types than silver-zinc batteries (i.e., silver-cadmium, nickel-cadmium, and lead-acid batteries). Perform the following operations:

(1) Select a channel and set the range switch to the tens digit of the desired voltage cutoff (0, 10, 20, or 30 volts). Set the unit and tenth volt-selector switches to the positions required to fully define the cutoff voltage.

NOTE

The maximum dialable cutoff voltage for the battery charge is 36.0 volts.

(2) Connect a charging cable from the selected channel. Observe correct polarity.

(3) Start the channel at the charge current recommended by the battery manufacturer. Observe that the CHARGING lamp turns on when the CHARGE CURRENT selector switch is in the START position.

NOTE

If the charging lamp does not stay on after the start action:

(1) The battery is at or above the selected cutoff voltage, (2) the charging connector has not been connected to the battery properly, or (3) the channel fuse is burned out. Refer to the special charging techniques in paragraph 3-2d. To manually stop the current while the battery is charging, turn the charge current selector switch to off.

(4) As the battery charges, its terminal voltage will rise. Upon reaching the full-charge cutoff voltage, the channel will automatically stop charging and the CHARGING lamp will turn off.

NOTE

The battery will, by its nature, decrease in voltage when the charging current stops.

SECTION 4

TROUBLESHOOTING

4-1. GENERAL. Troubleshooting information for the battery charger contains information describing the operation of the battery charger as a unit and as individual functional circuits. Included are listings of symptoms, probable causes, and remedies for trouble which could occur with the battery charger.

4-2. OVERALL FUNCTIONAL DESCRIPTION

a. The battery charger is a three-channel, current-regulated equipment with programmable cutoff voltage. Current from each channel is independently regulated by its own phase-angle-controlled electronic switch. The battery charger automatically stops the flow of charging current when the battery terminal voltage reaches the programmed cutoff voltage. A block diagram depicting the operation of a single charging channel appears in figure 4-1. Paragraphs 4-2b through f describe the operation of a typical charging channel.

b. The battery charger contains one power supply board which provides the entire equipment with the necessary working voltages, +5-volt reference supply, and a zero crossing signal required to synchronize the phase-angle-controlled electronic switch with the input power line voltage.

c. Before initiation of a charge, the desired upper cutoff voltage is selected. In the SILVER-ZINC range only, selection of the upper cutoff voltage also establishes a lower limit for the battery terminal voltage, below which the battery charger will not start.

d. In the OFF position, the CHARGE CURRENT selector switch sets the flip-flop and inhibits the flow of current to the battery. In the START position, the CHARGE CURRENT selector switch resets the flip-flop which turns on the CHARGING lamp and activates the current comparator. Current flow is inhibited, however, until the CHARGE CURRENT selector switch is released from the START position at which time current begins to flow at the selected charge rate.

e. During operation, the current comparator senses the current flowing to the battery and changes the slope of the ramp generator output to compensate for the range of different line frequencies and variations in line voltage and battery terminal voltage. The ramp generator output is synchronized at twice the line frequency by the zero crossing signal. When the ramp voltage level falls below 5 volts, the level sensor enables the electronic switch to conduct, permitting current to flow from the power bridge to the battery. The electronic switch conducts until the next zero crossing of the power line, at which time the ramp generator output is reset, turning off the electronic switch. Energy stored in the inductor during the conduction cycle of the electronic switch causes current to continue to flow into the battery at a diminishing rate through the free-wheeling diode. When the level of the ramp generator output signal falls below 5 volts, the current flow cycle is repeated.

f. When the battery terminal voltage reaches the programmed cutoff voltage, the voltage comparator sets the flip-flop which turns the CHARGING lamp off and inhibits the flow of charge current to the battery. The charge is completed.

4-3. FUNCTIONAL SECTION DESCRIPTIONS.

a. Power Supply Board. The power supply board provides operating voltages for the charge control circuitry. Figure 4-2 is a simplified schematic diagram of the circuitry of the power supply board. Complete circuit details can be found in figure 5-5.

(1) A full-wave bridge rectifies the output of the 20-volt secondary of transformer T101 (figure 5-6). The filtered bridge output is fed to a +10-volt to a -5-volt zener/transistor regulator where the +10-volt and +5-volt supply voltages are established. The common to -5-volt zener/transistor regulator establishes the system common line and a stable +5-volt reference level is generated by CR309.

(2) The unrectified transformer output is continuously monitored by the zero crossing detector. Each time the transformer voltage output drops to zero, a pulse is generated by the zero crossing detector. Transistors Q305 and Q306 shape the zero crossing pulse.

b. Control Board. The control boards each contain two principal circuits: a current comparator and a voltage comparator. Figure 4-3 shows a simplified schematic of a control board. Complete circuit detail for the control boards is found in figure 5-2.

(1) The current comparator, composed of Q407 and Q408, senses the current flowing to the battery and compensates for current variations due to fluctuations in line frequency, line voltage, and battery terminal voltage by changing the slop of the ramp generator output (Q411). The zero crossing signal synchronizes the ramp generator at twice the line frequency. Each time the ramp voltage falls below +5 volts, the level sensor, Q412, activates the electronic switch which passes current to the battery.

(2) The voltage comparator, composed of Q405 and Q406, continuously monitors the battery terminal voltage through the programming resistors of the voltage cutoff selector switches. This voltage is compared with a reference voltage and, when the battery terminal voltage reaches the preset cutoff

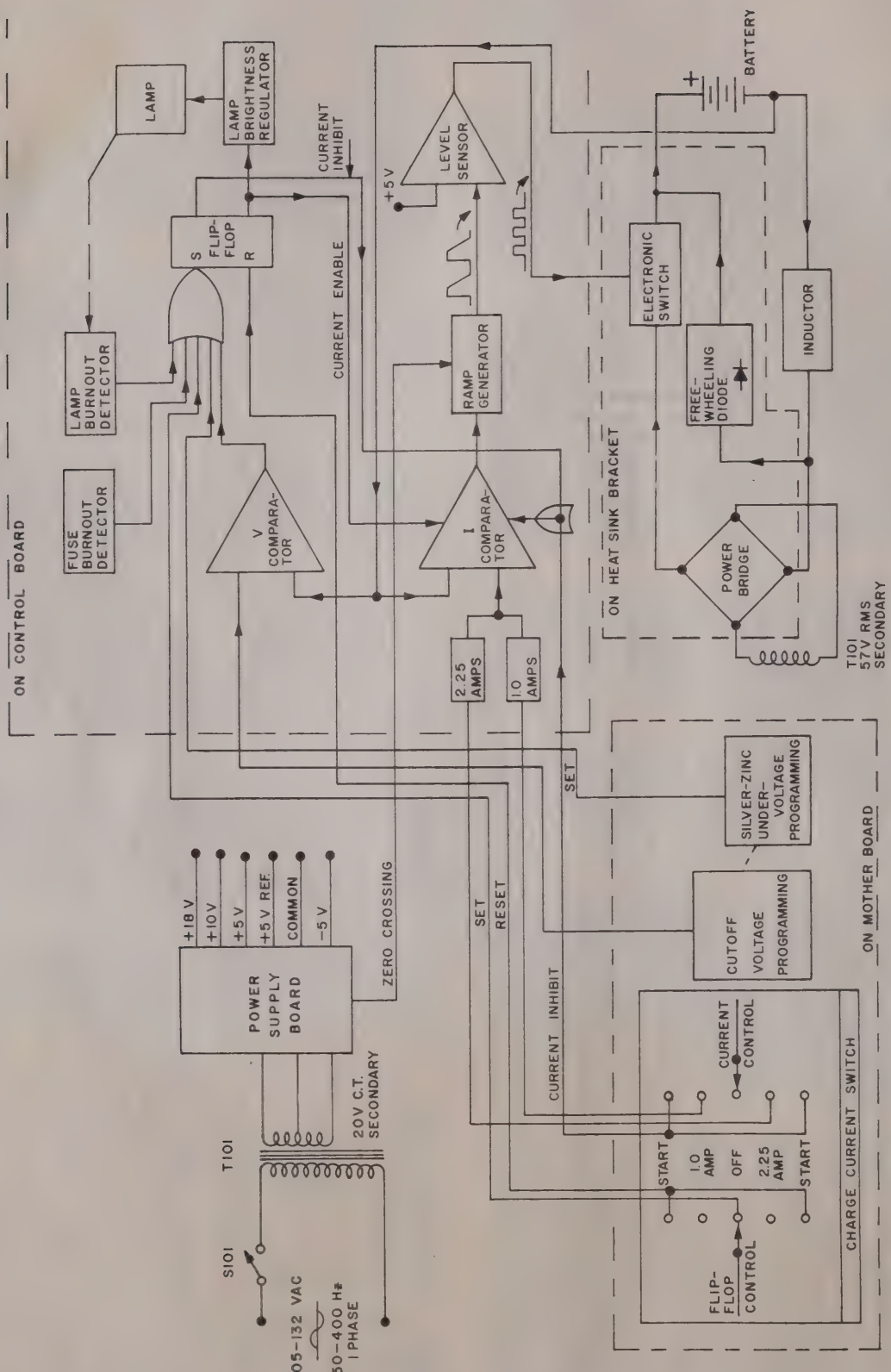


Figure 4-1. Functional Block Diagram

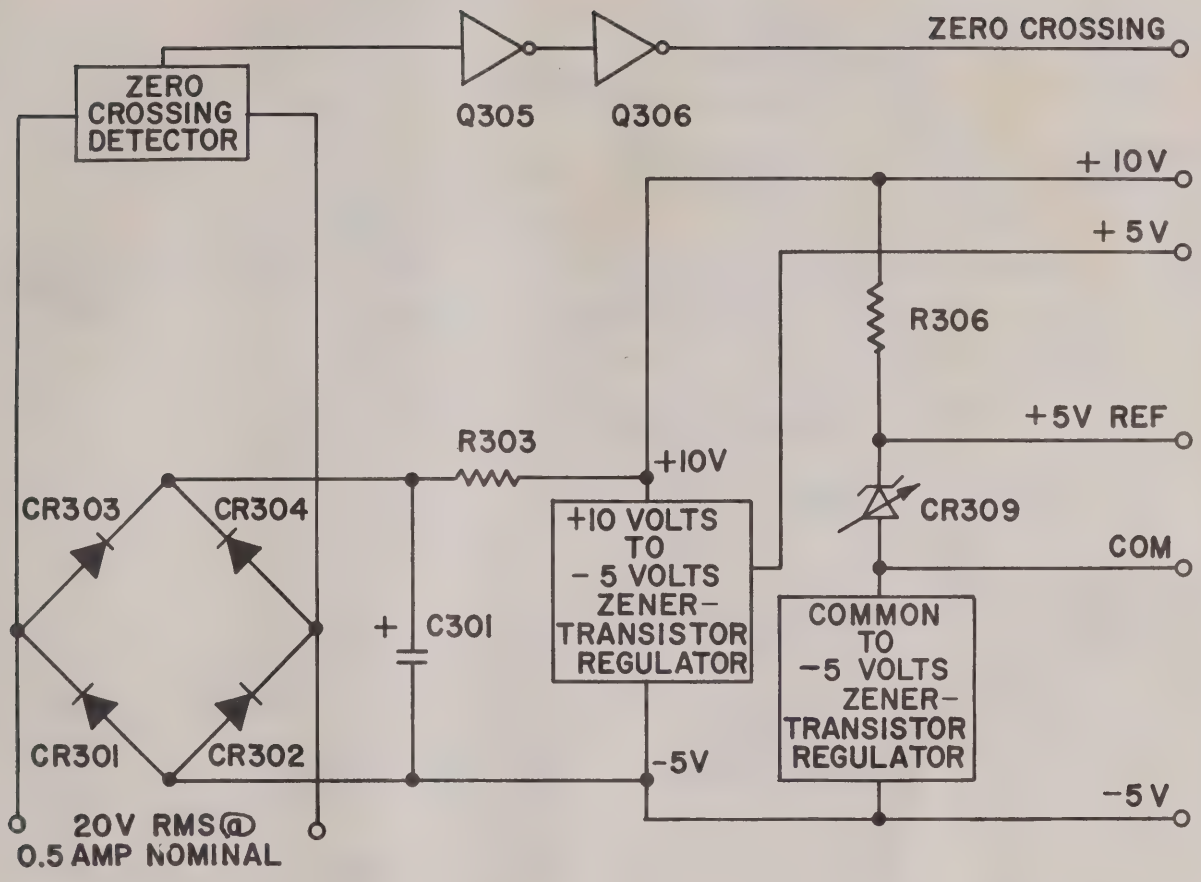


Figure 4-2. Simplified Schematic; Power Supply Board

voltage, the voltage comparator sets the flip-flop composed of Q402 and Q403, which inhibits the flow of charge current to complete the charge.

c. Master Board

(1) The master board contains the switches and programming resistors which establish desired voltage and current limits for charging. Figure 4-4 is a simplified diagram depicting the function of a single channel of the master board. Complete circuit details for the master board are contained in figure 5-3.

(2) Prior to initiation of a charge, the channel is set to the desired cutoff voltage by properly setting the voltage cutoff switches on the front panel. This action connects the battery to the voltage comparator on the control board through a programming resistance for comparison with a reference potential. Similar programming resistances are connected when the desired charge current is selected.

4-4. TROUBLESHOOTING. Troubleshooting information, found in table 4-1, is provided to assist the repair technician in recognition, isolation, and correction of faults which might occur with the battery charger.

TABLE 4-1. TROUBLESHOOTING INFORMATION

TROUBLE	PROBABLE CAUSE	REMEDY
No CHARGING Lamps light during	POWER/ON switch is off.	Set POWER/ON switch to ON
START action.	Input fuse burned out.	Replace input fuse.
	Power supply board is defective.	Replace power supply board.

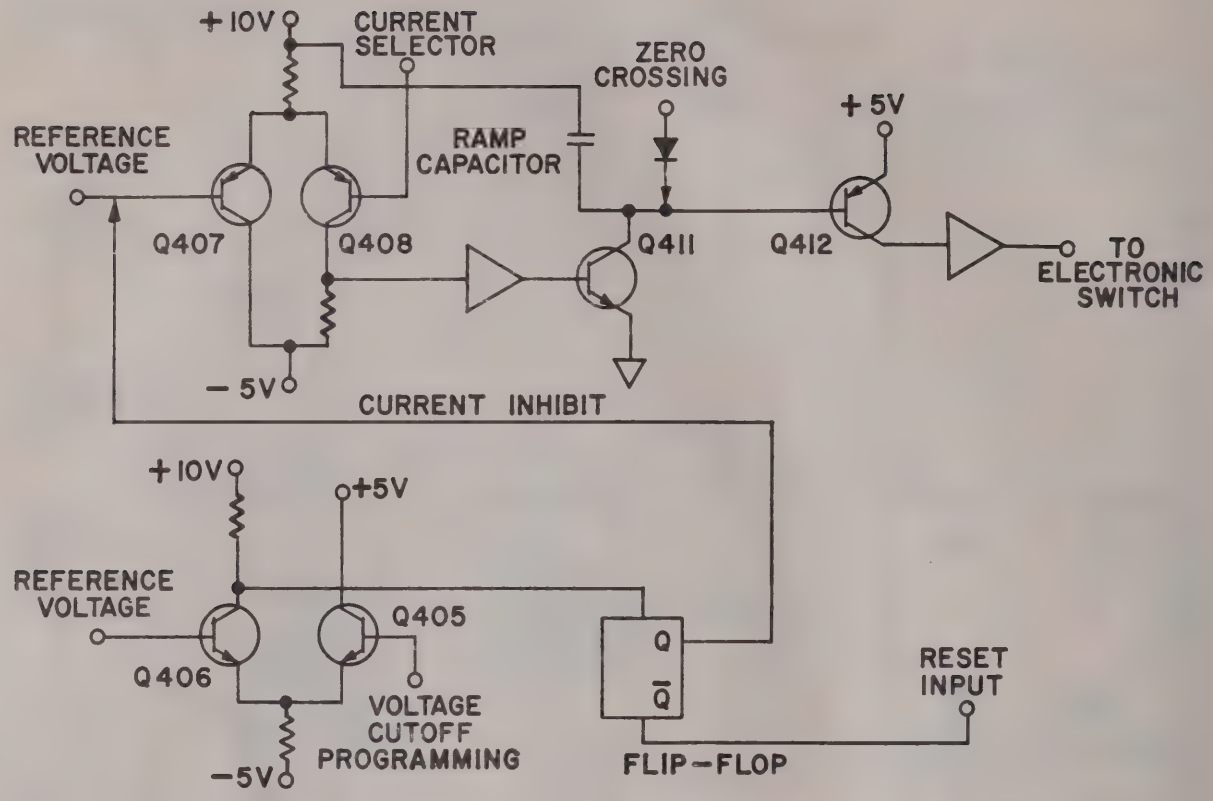


Figure 4-3. Simplified Schematic; Control Board

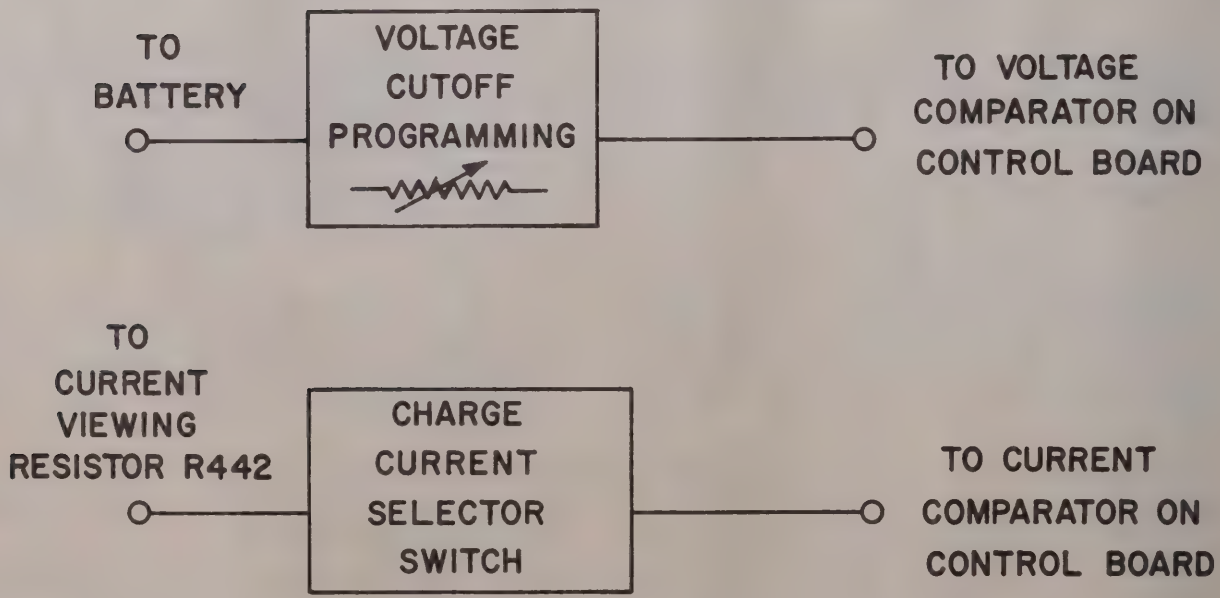


Figure 4-4. Simplified Schematic; One Channel of Master Board

TABLE 4-1. TROUBLESHOOTING INFORMATION (Cont.)

TROUBLE	PROBABLE CAUSE	REMEDY
One channel will not start.	Channel output fuse is burned out.	Replace channel output fuse.
	Channel CHARGING lamp is burned out.	Replace channel CHARGING lamp.
	Battery voltage too high.	No action required; battery is already charged.
	If on SILVER-ZINC range, battery voltage is too low.	Set to the desired cutoff voltage in the ADJUSTABLE Cutoff voltage range and start.
	Charging cable improperly connected to battery charger or battery.	Secure to obtain proper connection.
	Charging cable is defective.	Replace charging cable.
	Power supply board is defective.	Replace power supply board.
	Control board is defective.	Replace control board.
	Master board is defective.	Replace master board.
Channel fuse blows.	Battery connected in reverse polarity.	Connect battery in correct polarity and replace fuse.
Battery charger will not calibrate for zero volts cutoff.	Control board is defective.	Replace control board.
Battery charger will not calibrate for cutoff voltage.	Power supply board is defective.	Replace power supply board.
Battery charger will not calibrate for charge current.	Control board is defective.	Replace control board.

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SECTION 5

MAINTENANCE

5-1. PREVENTIVE MAINTENANCE. The battery charger is designed to require a minimum of preventive maintenance. Once each month, clean the exterior surfaces (case and front panel) by wiping with a clean, damp cloth. Twice each year, inspect the power cable and charging cables for signs of wear. Simple cracks or splits of the cable insulation (i.e., no interior conductors are exposed) may be repaired by wrapping the defects with electrical tape. Where a crack or split leaves an interior conductor exposed, the cable must be replaced.

5-2. CALIBRATION. Calibration procedures for the battery charger are divided into two parts: checks for proper calibration, and procedures for recalibration of the equipment. When the calibration of the battery charger is to be checked, the two calibration checks must be performed in the order presented. Calibration checks and the recalibration procedures must be performed with the battery charger at room temperature.

a. Calibration Test Equipment. The test equipment required for calibration checks and recalibration procedures of the battery charger are listed in table 5-1.

b. Calibration Check Part I; Cutoff Voltage. The calibration check for cutoff voltage should be performed for each channel. Perform the following operations:

(1) Select any storage battery with a terminal voltage greater than 20 volts.

(2) Connect a general purpose charging cable to the battery charger and to the battery. Be sure to observe correct polarities.

(3) Connect a voltmeter (accurate to within 1% of the indication) across the battery terminals. Be sure of correct polarities.

(4) Measure and record the terminal voltage of the battery (V_b).

(5) Use the value obtained in step (4) to calculate the battery voltage plus 3% (i.e., $V_b + 0.03 V_b$). Record the result.

(6) Use the value obtained in step (4) to calculate the battery voltage minus 3% (i.e., $V_b - 0.03 V_b$). Record the result.

(7) Set the range switch, unit volts selector switch, and tenth volts selector switch for a cutoff voltage equal to the value obtained in step (6).

(8) Turn the CHARGE CURRENT selector switch to its 1.0 A START position and hold. The CHARGING lamp will be illuminated with the CHARGE CURRENT selector switch in the START position.

(9) Release the CHARGE CURRENT selector switch from the START position. The CHARGING lamp should turn off immediately.

(10) If the CHARGING lamp remains illuminated longer than 1/2-second after the CHARGE CURRENT switch is released from the START position, recalibration is necessary. Perform parts II and III of the recalibration procedure. See paragraphs 5-2e and f.

(11) Set the channel for a cutoff voltage equal to the value obtained in step (5).

(12) Turn the CHARGE CURRENT selector switch to its 1.0 A START position and hold. The CHARGING lamp will be illuminated with the CHARGE CURRENT selector switch in the START position.

TABLE 5-1. CALIBRATION TEST EQUIPMENT

NOMENCLATURE	APPLICATION	RANGE	ACCURACY
Voltmeter	Calibration checks	0-100 vdc	±1% of indication (Model 310A; Western Reserve Electronics, Inc.: FSN 6625-420-6143 or Model 300M; Western Reserve Electronics, Inc.: FSN 6625-933-2406 or equivalent)
Ammeter	Calibration	0-1 ampere	±1% of indication (Model 300M; Western Reserve Electronics, Inc.: FSN 6624-933-2406 or equivalent)
Voltmeter	Recalibration	0-10 vdc	±0.1% of indication

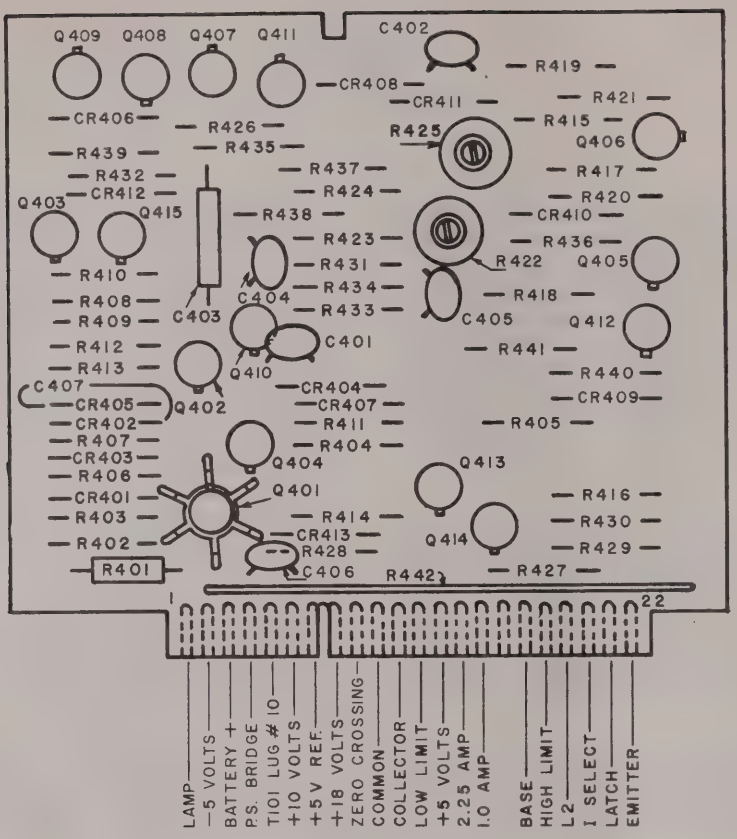


Figure 5-1. Component Locations; Control Board

(13) Release the CHARGE CURRENT selector switch from the START position. The CHARGING lamp should stay on longer than 1/2-second.

(14) If the CHARGING lamp turns off immediately after the CHARGE CURRENT selector switch is released from the START position, recalibration is necessary. Perform parts II and III of the recalibration procedure. See paragraphs 5-2e and f.

c. Calibration Check Part II; Charge Current. The charge current calibration check must be performed for each of the three charging channels. Perform the following operations:

(1) Connect a storage battery with a terminal voltage greater than 20 volts in series with an ammeter to the channel of the battery charger.

(2) Set the range switch, unit volts selector switch, and tenth volts selector switch for a cutoff voltage of 30.0 volts.

(3) Set the CHARGE CURRENT selector switch to 1.0 A and start.

(4) Observe an indication of 1.00 amperes ± 5% (i.e., 0.95 to 1.05 amperes) on the ammeter.

(5) If the ammeter indication is not within the limits specified in step (4), recalibration is necessary. Perform part III of the recalibration procedures. See paragraph 5-2f.

d. Recalibration Part I; Zero Volts Cutoff. The recalibration procedure for zero volts cutoff must be performed for each of the three charging channels. Perform the following operations:

(1) Remove the charger assembly from its case bottom by performing the operations outlined in paragraph 5-5.

(2) Connect the input power cable to the battery charger and to a source of line voltage.

WARNING (1)

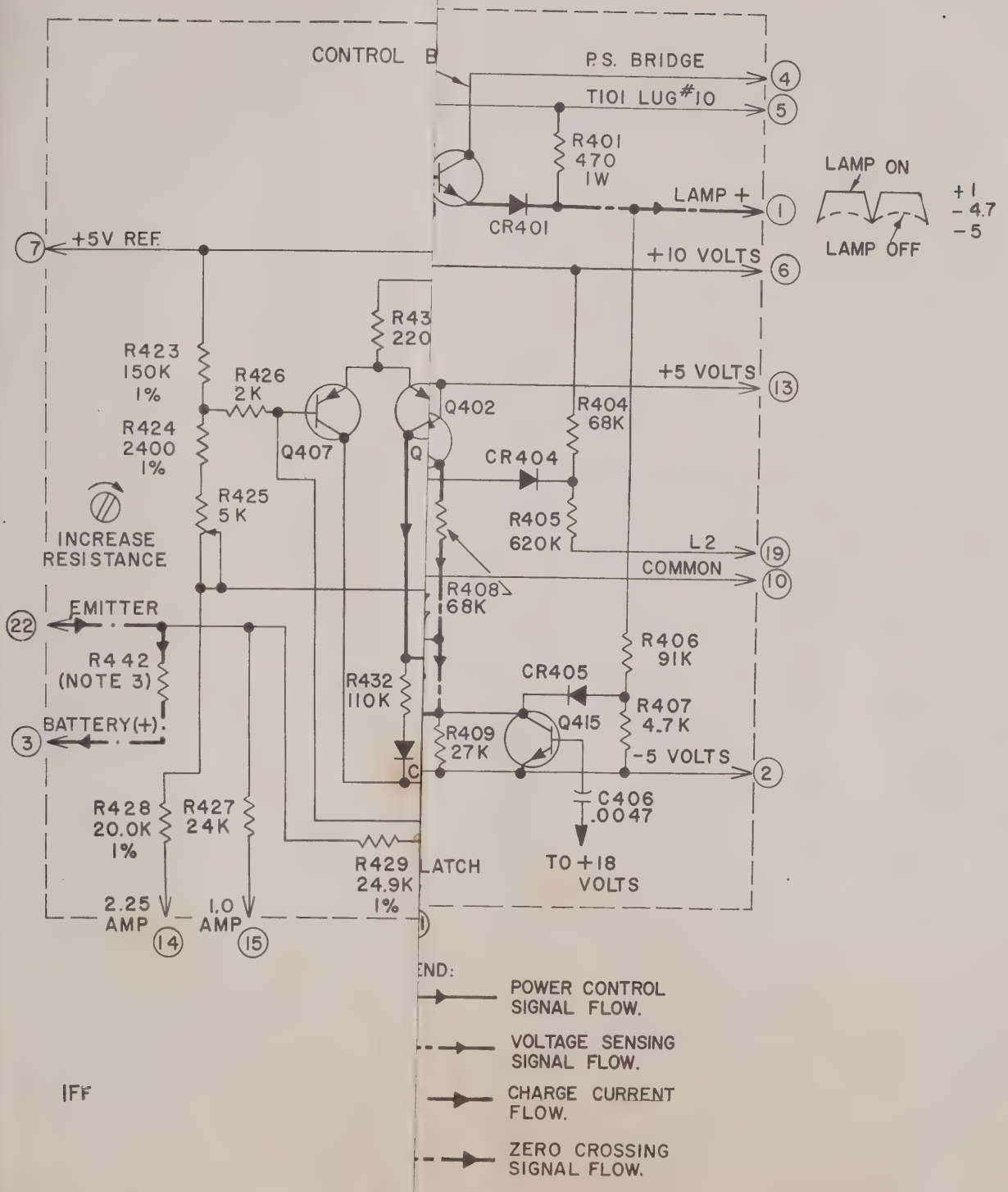
DANGEROUS VOLTAGES ARE EXPOSED WITH THE CASE BOTTOM REMOVED. CAUTION SHOULD BE EXERCISED TO AVOID INJURY.

(3) Set the POWER/ON switch to ON.

(4) Connect a general purpose charging cable to the channel to be calibrated and short the cable clips together.

(5) Temporarily short circuit the base to emitter of Q404. See figures 5-1 and 5-2.

(6) Set the range switch, unit volts selector switch, and tenth volts selector switch on the channel to be calibrated for a cutoff voltage of 00.0 volts.



Schematic Diagram; Control Board

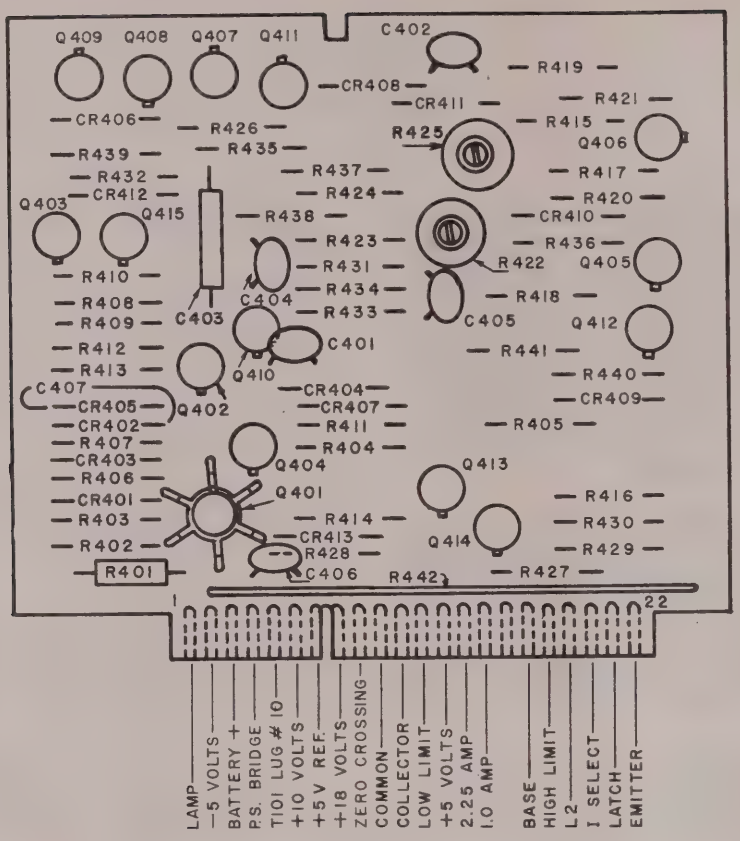


Figure 5-1. Component Locations; Control Board

(13) Release the CHARGE CURRENT selector switch from the START position. The CHARGING lamp should stay on longer than 1/2-second.

(14) If the CHARGING lamp turns off immediately after the CHARGE CURRENT selector switch is released from the START position, recalibration is necessary. Perform parts II and III of the recalibration procedure. See paragraphs 5-2e and f.

c. Calibration Check Part II; Charge Current. The charge current calibration check must be performed for each of the three charging channels. Perform the following operations:

(1) Connect a storage battery with a terminal voltage greater than 20 volts in series with an ammeter to the channel of the battery charger.

(2) Set the range switch, unit volts selector switch, and tenth volts selector switch for a cutoff voltage of 30.0 volts.

(3) Set the CHARGE CURRENT selector switch to 1.0 A and start.

(4) Observe an indication of 1.00 amperes ± 5% (i.e., 0.95 to 1.05 amperes) on the ammeter.

(5) If the ammeter indication is not within the limits specified in step (4), recalibration is necessary. Perform part III of the recalibration procedures. See paragraph 5-2f.

d. Recalibration Part I; Zero Volts Cutoff. The recalibration procedure for zero volts cutoff must be performed for each of the three charging channels. Perform the following operations:

(1) Remove the charger assembly from its case bottom by performing the operations outlined in paragraph 5-5.

(2) Connect the input power cable to the battery charger and to a source of line voltage.

WARNING (1)

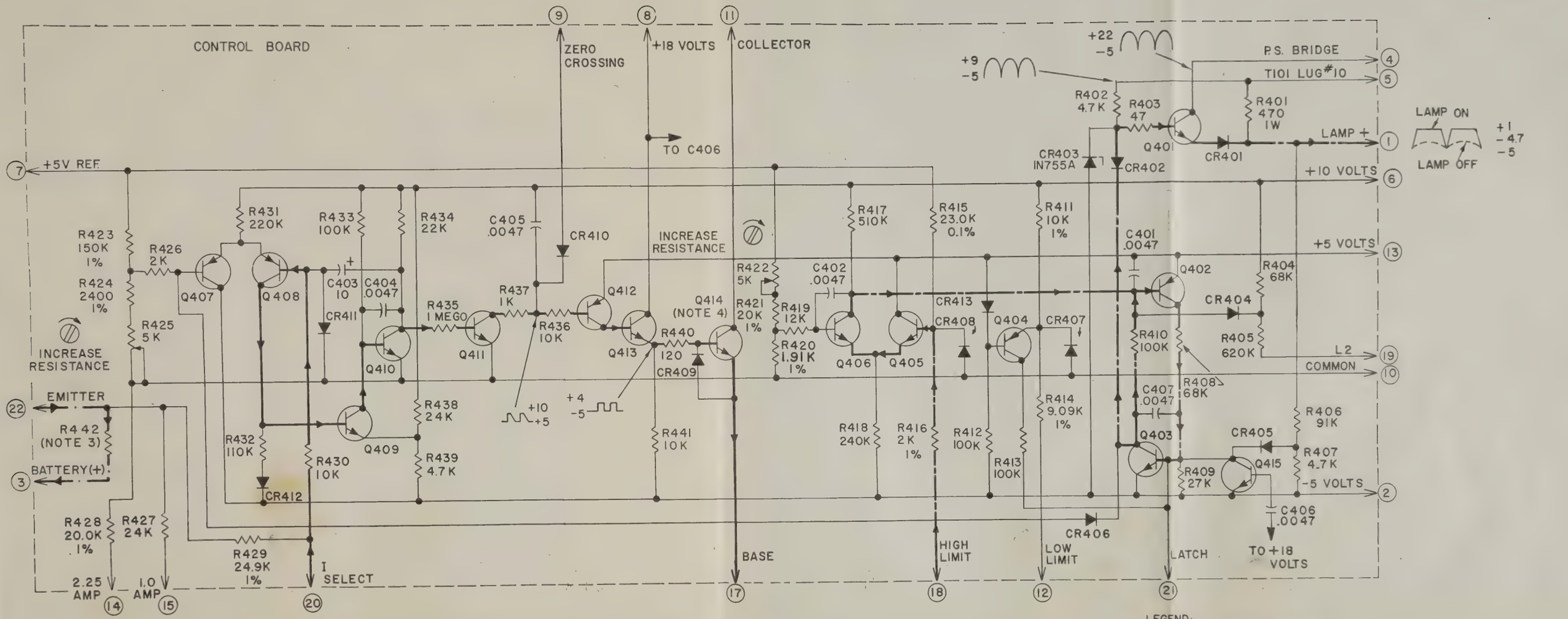
DANGEROUS VOLTAGES ARE EXPOSED WITH THE CASE BOTTOM REMOVED. CAUTION SHOULD BE EXERCISED TO AVOID INJURY.

(3) Set the POWER/ON switch to ON.

(4) Connect a general purpose charging cable to the channel to be calibrated and short the cable clips together.

(5) Temporarily short circuit the base to emitter of Q404. See figures 5-1 and 5-2.

(6) Set the range switch, unit volts selector switch, and tenth volts selector switch on the channel to be calibrated for a cutoff voltage of 00.0 volts.



NOTES:

1. CIRCLED NUMBERS ARE CONNECTOR PIN NUMBERS J202, J203, & J204.
2. UNLESS OTHERWISE SPECIFIED:
   PNP TRANSISTORS ARE JAN 2N2905A,
   NPN TRANSISTORS ARE JAN 2N2219A,
   DIODES ARE JAN IN 645,
   RESISTANCE VALUES ARE IN OHMS,
   CAPACITANCE VALUES ARE IN MICROFARADS,
   RESISTORS ARE ±5%, 1/2 WATT.
3. R442 IS 20 AWG MANGANIN WIRE, APPROXIMATELY FOUR INCHES LONG.
4. Q414 IS W.R.E., INC. P/N 929-3-000002 TRANSISTORS APPROVED FOR THIS APPLICATION ARE MOTOROLA P/N MM2262 OR RCA P/N 40349 OR EQUIVALENT.
5. WAVEFORM MEASUREMENTS MADE WITH 10 MEGO PROBE, 120 VAC. LINE.

LEGEND:

- POWER CONTROL SIGNAL FLOW.
- VOLTAGE SENSING SIGNAL FLOW.
- CHARGE CURRENT FLOW.
- ZERO CROSSING SIGNAL FLOW.

IFF

Figure 5-2. Schematic Diagram; Control Board

NOTES:

1. SWITCH S-a SHOWN IN OFF POSITION.
2. SWITCH S-b, S-c, S-d, SHOWN IN ZERO POSITION.
3. SWITCHES VIEWED FROM KNOB END.
4. DIODES ARE JAN IN1202A.
5. RESISTANCE VALUES ARE IN OHMS.
6. RESISTORS ARE ±1% UNLESS OTHERWISE SPECIFIED.
7. SEE TABLE FOR COMPONENT REFERENCE DESIGNATIONS ASSOCIATED WITH EACH CHANNEL.
8. WAVEFORM MEASUREMENTS MADE WITH 10 MEGO PROBE, 120 VAC. LINE.

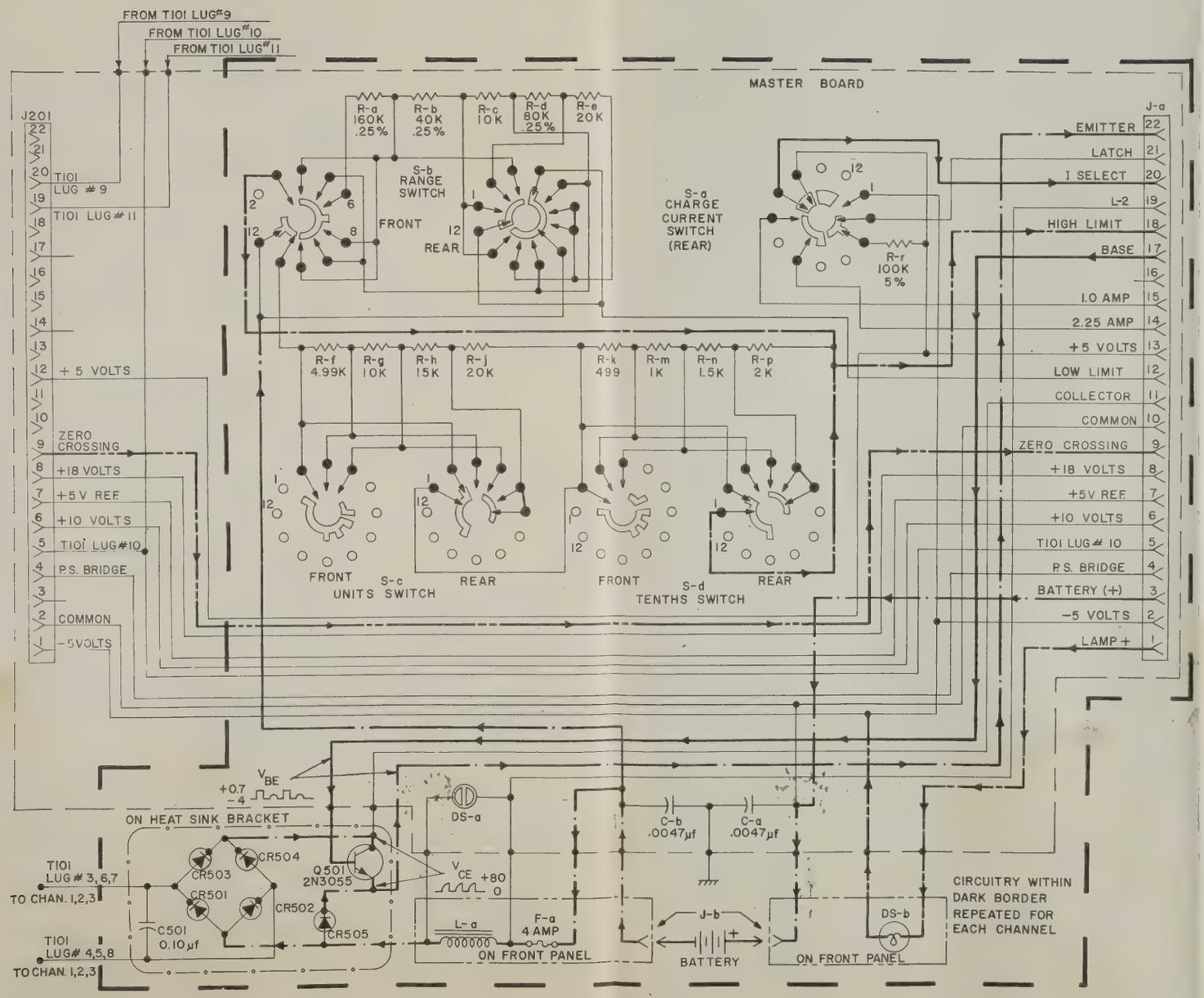
DESIG	CHANNEL		
	1	2	3
C-a	C201	C203	C205
C-b	C202	C204	C206
DS-a	DS201	DS202	DS203
DS-b	DS101	DS102	DS103
F-a	F102	F103	F104
J-a	J202	J203	J204
J-b	J102	J103	J104
L-a	L101	L102	L103
R-a	R203	R217	R231
R-b	R201	R215	R229
R-c	R204	R218	R232
R-d	R202	R216	R230
R-e	R205	R219	R233
R-f	R206	R220	R234
R-g	R207	R221	R235
R-h	R208	R222	R236
R-j	R209	R223	R237
R-k	R210	R224	R238
R-m	R211	R225	R239
R-n	R212	R226	R240
R-p	R213	R227	R241
R-r	R214	R228	R242
S-a	S201	S205	S209
S-b	S202	S206	S210
S-c	S203	S207	S211
S-d	S204	S208	S212

LEGEND:
- ——— POWER CONTROL SIGNAL FLOW.
- —▸ - - VOLTAGE SENSING SIGNAL FLOW.
- —▸ · — CHARGE CURRENT FLOW.
- —▸ - - - ZERO CROSSING SIGNAL FLOW.

TO

TO

ematic Diagram; Master Board



NOTES:

1. SWITCH S-a SHOWN IN OFF POSITION.
2. SWITCH S-b, S-c, S-d, SHOWN IN ZERO POSITION.
3. SWITCHES VIEWED FROM KNOB END.
4. DIODES ARE JAN IN1202A.
5. RESISTANCE VALUES ARE IN OHMS.
6. RESISTORS ARE ±1% UNLESS OTHERWISE SPECIFIED.
7. SEE TABLE FOR COMPONENT REFERENCE DESIGNATIONS ASSOCIATED WITH EACH CHANNEL.
8. WAVEFORM MEASUREMENTS MADE WITH 10 MEGO PROBE, 120 VAC. LINE.

DESIG	CHANNEL		
	1	2	3
C-a	C201	C203	C205
C-b	C202	C204	C206
DS-a	DS201	DS202	DS203
DS-b	DS101	DS102	DS103
F-a	F102	F103	F104
J-a	J202	J203	J204
J-b	J102	J103	J104
L-a	L101	L102	L103
R-a	R203	R217	R231
R-b	R201	R215	R229
R-c	R204	R218	R232
R-d	R202	R216	R230
R-e	R205	R219	R233
R-f	R206	R220	R234
R-g	R207	R221	R235
R-h	R208	R222	R236
R-j	R209	R223	R237
R-k	R210	R224	R238
R-m	R211	R225	R239
R-n	R212	R226	R240
R-p	R213	R227	R241
R-r	R214	R228	R242
S-a	S201	S205	S209
S-b	S202	S206	S210
S-c	S203	S207	S211
S-d	S204	S208	S212

LEGEND:
- POWER CONTROL SIGNAL FLOW.
- VOLTAGE SENSING SIGNAL FLOW.
- CHARGE CURRENT FLOW.
- ZERO CROSSING SIGNAL FLOW.

Figure 5-3. Schematic Diagram; Master Board

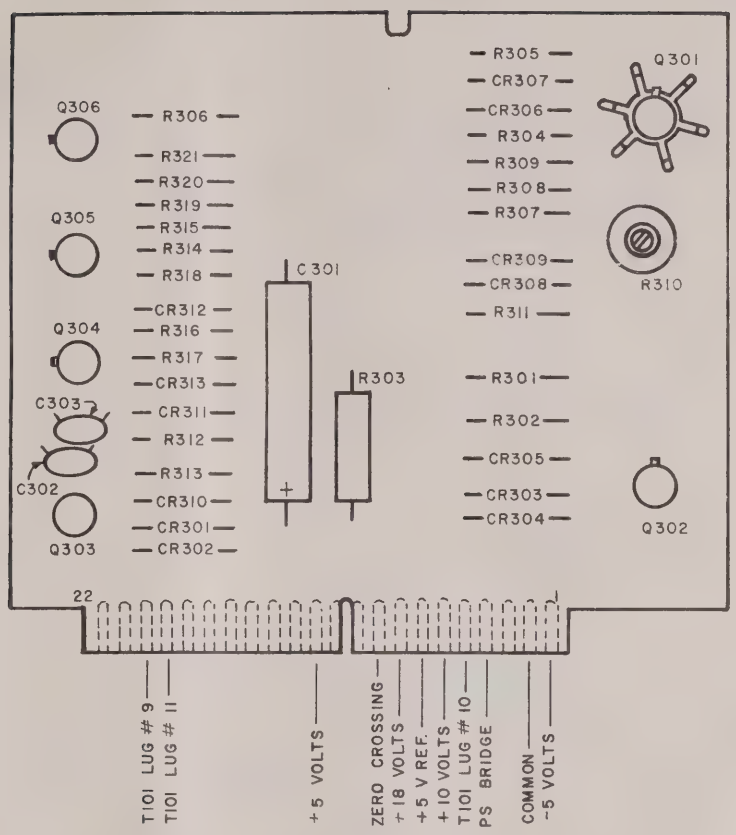


Figure 5-4. Component Locations; Power Supply Board

(7) Turn the shaft of potentiometer R422 on the control board of the channel to be calibrated full clockwise. See figure 5-2.

(8) Set the CHARGE CURRENT selector switch of the channel under test to its 1.0 A START position and release. Repeat this operation at 1/2-second intervals while performing step (9).

(9) The CHARGING lamp will remain on when the CHARGE CURRENT selector switch is released from the START position in step (8) above. Slowly adjust the shaft position of R422 until the CHARGING lamp turns off immediately after the CHARGE CURRENT selector switch is released from its START position.

(10) Remove the short circuit between the base and emitter of Q404.

(11) The zero volts cutoff of the channel is calibrated.

e. Recalibration Part II; Cutoff Voltage. The recalibration procedure for cutoff voltage does not need to be performed for each channel. The procedure must be performed on only one channel to calibrate the cutoff voltage for the entire equipment. Perform the following operations:

(1) Remove the charger assembly from its case bottom by performing the operations outlined in paragraph 5-5.

(2) Connect the input power cable to the battery charger and to a source of line voltage.

WARNING (2)
DANGEROUS VOLTAGES ARE EXPOSED WITH THE CASE BOTTOM REMOVED. CAUTION SHOULD BE EXERCISED TO AVOID INJURY.

(3) Turn the POWER/ON switch to ON.

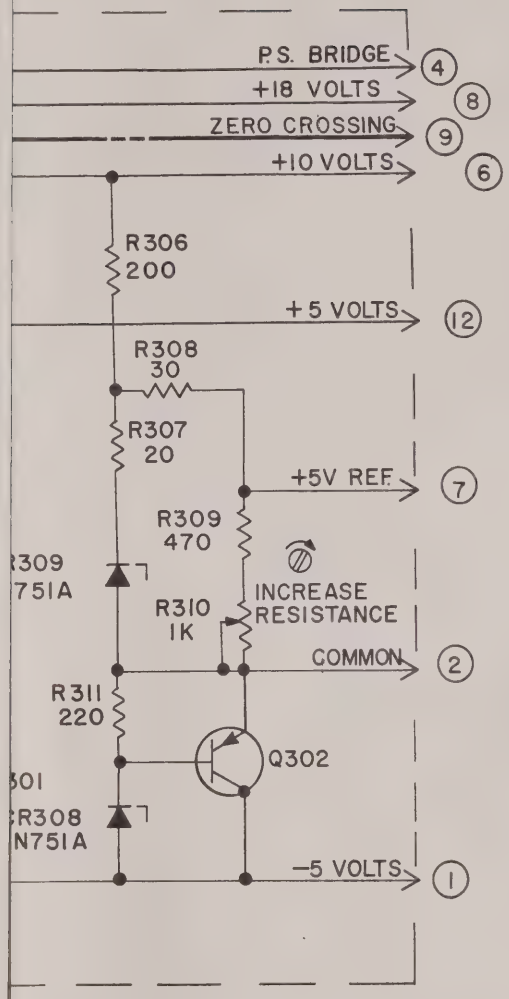
(4) Connect the general purpose charging cables to two channels and short the cable clips of each channel together.

(5) Set the range switch, unit volts selector switch, and tenth volts selector switch on the two channels with charging cables for a cutoff voltage of 00.0 volts.

(6) Set the remaining channel for a cutoff voltage of 36.0 volts.

(7) Connect the positive lead of a voltmeter (accurate to within 0.1% of the indication) to pin #7 of J201 on the master board. See figure 5-3.

(8) Connect the negative lead of the voltmeter to pin #2 of J201 on the master board.



S:

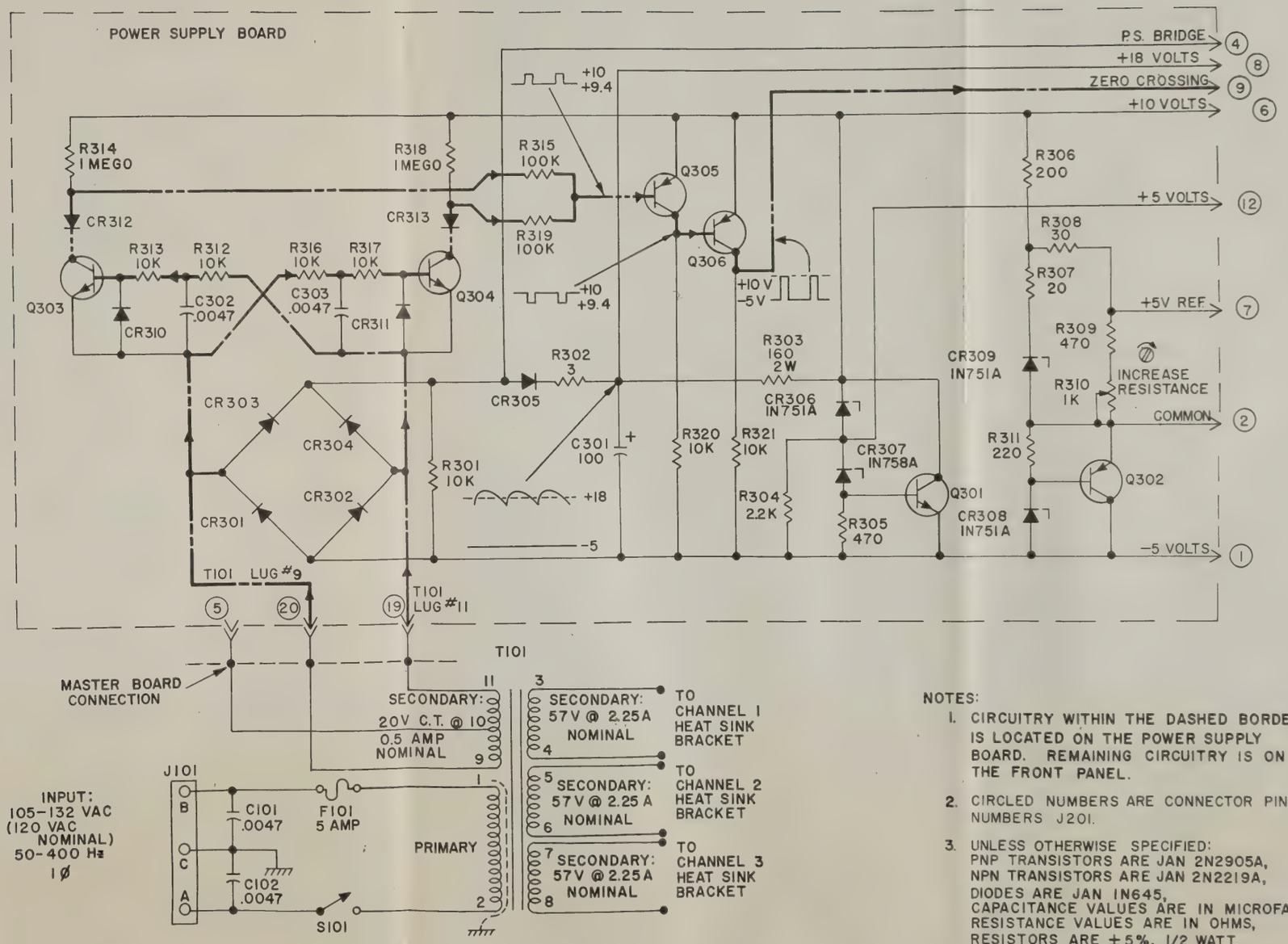
CIRCUITRY WITHIN THE DASHED BORDER IS LOCATED ON THE POWER SUPPLY BOARD. REMAINING CIRCUITRY IS ON THE FRONT PANEL.

CIRCLED NUMBERS ARE CONNECTOR PIN NUMBERS J201.

UNLESS OTHERWISE SPECIFIED:
PNP TRANSISTORS ARE JAN 2N2905A,
NPN TRANSISTORS ARE JAN 2N2219A,
DIODES ARE JAN 1N645,
CAPACITANCE VALUES ARE IN MICROFARADS,
RESISTANCE VALUES ARE IN OHMS,
RESISTORS ARE ±5%, 1/2 WATT.

WAVEFORM MEASURMENTS MADE WITH 10 MEGO PROBE, 120 VAC LINE.

natic Diagram; Power Supply Board



NOTES:

1. CIRCUITRY WITHIN THE DASHED BORDER IS LOCATED ON THE POWER SUPPLY BOARD. REMAINING CIRCUITRY IS ON THE FRONT PANEL.
2. CIRCLED NUMBERS ARE CONNECTOR PIN NUMBERS J201.
3. UNLESS OTHERWISE SPECIFIED:
   PNP TRANSISTORS ARE JAN 2N2905A,
   NPN TRANSISTORS ARE JAN 2N2219A,
   DIODES ARE JAN 1N645,
   CAPACITANCE VALUES ARE IN MICROFARADS,
   RESISTANCE VALUES ARE IN OHMS,
   RESISTORS ARE ±5%, 1/2 WATT.
4. WAVEFORM MEASURMENTS MADE WITH 10 MEGO PROBE, 120 VAC LINE.

Figure 5-5. Schematic Diagram; Power Supply Board

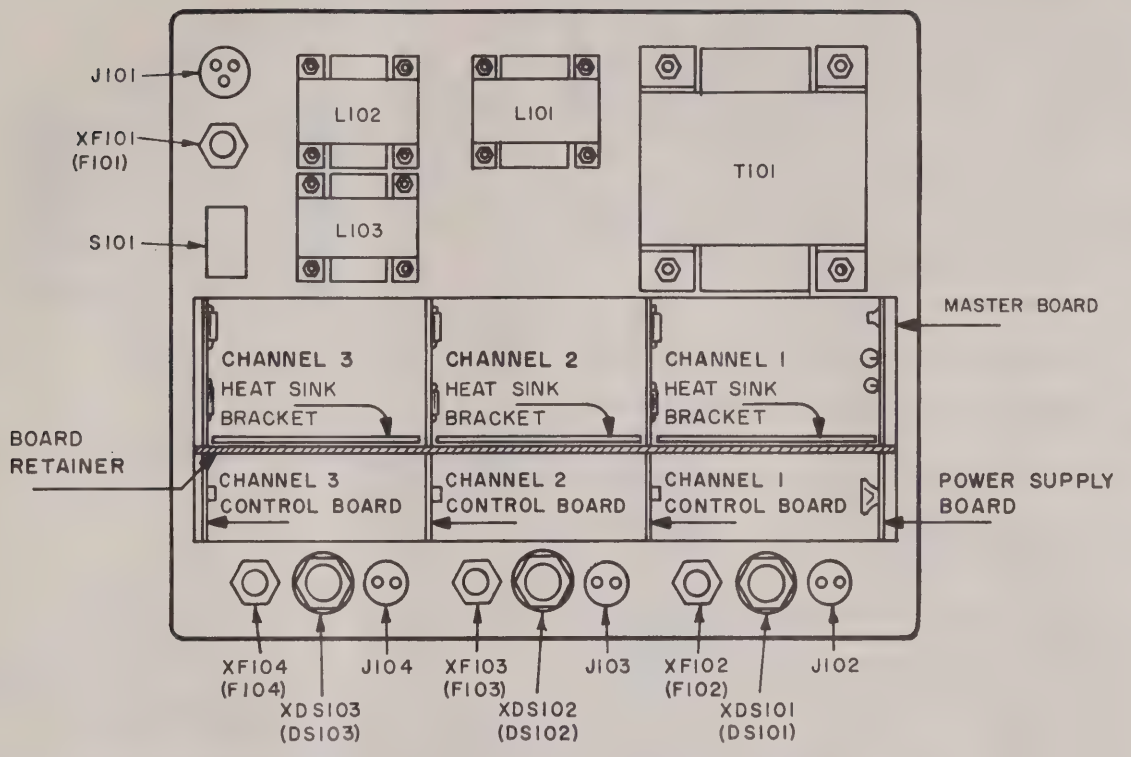


Figure 5-6. Component Locations; Rear of Front Panel

(9) Adjust the potentiometer, R310, on the power supply board (figures 5-4 and 5-5) until the voltmeter indicates 5.014 volts.

(10) The cutoff voltage of the entire equipment is calibrated; however, it is necessary that the procedures outlined in paragraph 5-2f be performed.

f. Recalibration Part III; Charge Current. The calibration procedure for charge current must be performed for each channel. Perform the following operations:

(1) Remove the charger assembly from its case bottom by performing the operations outlined in paragraph 5-5.

(2) Connect the input power cable to the battery charger and to a source of line voltage.

WARNING (3)

DANGEROUS VOLTAGES ARE EXPOSED WITH THE CASE BOTTOM REMOVED. CAUTION SHOULD BE EXERCISED TO AVOID INJURY.

(3) Turn the POWER/ON switch to ON.

(4) Connect a storage battery with a terminal voltage greater than 20 volts in series with an ammeter (set to its 1-ampere range) to the channel of the battery charger.

(5) Set the range switch, unit volts selector switch, and tenth volts selector switch for a cutoff voltage of 36.0 volts.

(6) Start the channel at 1.0 amperes.

CAUTION

DO NOT SWITCH AMMETER RANGES WHILE CHARGING LAMP IS ON.

(7) Adjust the position of the shaft of potentiometer R425 on the control board (figures 5-1 and 5-2) of the channel to be calibrated to obtain an indication of 1.00 amperes as indicated by the ammeter.

5-3. FUSE REPLACEMENT. Fuses in the input power line and at the output of each channel are replaceable from the front panel. A blown fuse can indicate a malfunction in the portion of the equipment circuitry associated with the fuse. Therefore, it is advised that, before replacing any fuse, the cause of the burnout be determined and the fault corrected. Before replacing a channel fuse, disconnect the charging cable associated with the fuse. Remove the input power cable before replacing the input fuse. The fuse can be replaced by pressing firmly down on the fuseholder can and rotating the cap one-quarter turn in the counterclockwise direction. Remove the fuse from its receptacle and replace it with the required replacement type (i.e., input fuse is Standard 3AG-5 amperes; output fuses are Standard 3AG-4 amperes).

5-4. LAMP REPLACEMENT. The CHARGING lamps are replaceable from the front panel through the following procedure. Unscrew the lens cap and remove the lamp by pressing firmly down on the lamp bulb and rotating the lamp one-quarter turn in the counterclockwise direction. Remove the lamp from its receptacle and replace it with a Type 47 lamp.

5-5. CHARGER ASSEMBLY REMOVAL. Access to the battery charger's control circuitry is gained by removing the front panel from the case bottom. Perform the following procedures:

a. Turn the battery charger off.

b. Disconnect all cables from the battery charger.

c. Unfasten the 18 screws around the perimeter of the front panel.

d. Carefully lift the front panel from its case.

5-6. REPLACEMENT OF POWER SUPPLY BOARD AND CONTROL BOARDS.

a. For maintenance purposes, the charging channels are numbered one, two, and three, beginning with the leftmost channel as viewed from the front panel. To aid in locating the desired control board for replacement, the following table has been prepared to show the correspondence between the channel numbers and the connector designations on the master board which secure the associated control board. The power supply board is included in the listing.

TABLE 5-2. BOARD LOCATION

CHANNEL NO.	CONNECTOR DESIGNATION
1	J202
2	J203
3	J204
Power Supply Board	J201

b. Removal and replacement of the power supply board or control boards are performed through the following procedures:

(1) Remove the charger assembly from its case bottom by performing the operations outlined in paragraph 5-5.

(2) Remove the board retainer by turning the three fasteners along its length one-quarter turn in the counterclockwise direction and lifting it from its position.

(3) Carefully pull the desired board straight out from its connector and replace. See figure 5-6 and table 5-2.

5-7. REPLACEMENT OF MASTER BOARD. To remove and replace the master board, perform the following operations:

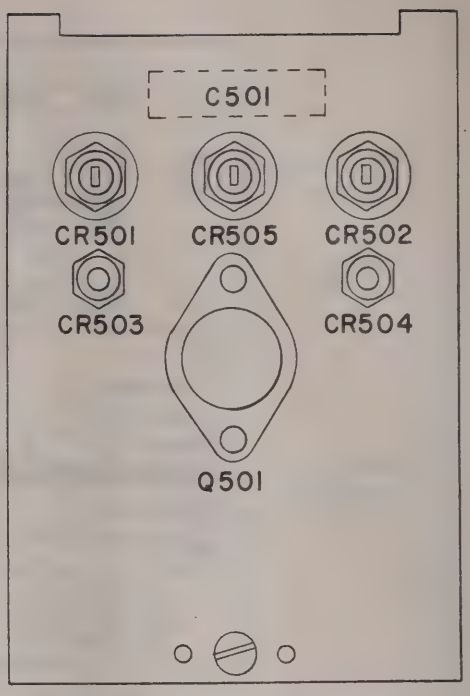


Figure 5-7. Component Locations; Heat Sink Bracket

a. Remove the charger assembly from its case bottom by performing the operations outlined in paragraph 5-5.

b. Remove the board retainer by turning the three fasteners along its length one-quarter turn in the counterclockwise direction and lifting it from its position.

c. Carefully pull the three control boards and the power supply board straight out from their connectors on the master board. See figure 5-6.

d. Unsolder all of the wires which connect to the heat sink brackets and the component side on the master board. These wires are to be unsoldered at the component end of the wire, not at the master board end. See figures 5-6, 5-7, and 5-8.

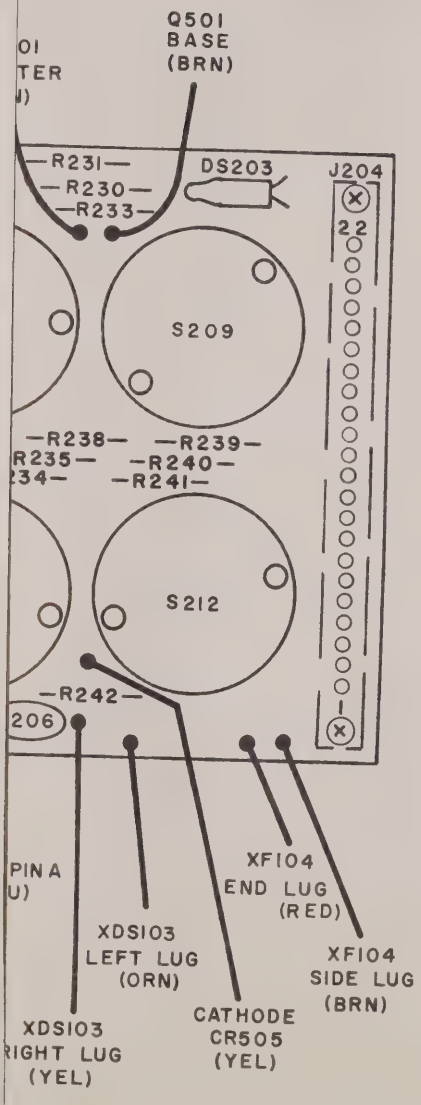
e. At the side terminal of each of the channel output fuse holders, unsolder the wire which extends across the connector side of the master board.

f. On the front panel, remove all the rotary switch knobs and all the hardware securing the rotary switches to the front panel.

g. Carefully lift the master board from its position on the front panel.

h. Remove the three heat sink brackets from the master board by unfastening the two screws which secure each bracket to the master board.

i. Removal of the master board is complete. To replace the master board, reverse the foregoing procedure.



nponent Locations; Master Board

5-4. LAMP REPLACEMENT. The CHARGING lamps are replaceable from the front panel through the following procedure. Unscrew the lens cap and remove the lamp by pressing firmly down on the lamp bulb and rotating the lamp one-quarter turn in the counterclockwise direction. Remove the lamp from its receptacle and replace it with a Type 47 lamp.

5-5. CHARGER ASSEMBLY REMOVAL. Access to the battery charger's control circuitry is gained by removing the front panel from the case bottom. Perform the following procedures:

a. Turn the battery charger off.

b. Disconnect all cables from the battery charger.

c. Unfasten the 18 screws around the perimeter of the front panel.

d. Carefully lift the front panel from its case.

5-6. REPLACEMENT OF POWER SUPPLY BOARD AND CONTROL BOARDS.

a. For maintenance purposes, the charging channels are numbered one, two, and three, beginning with the leftmost channel as viewed from the front panel. To aid in locating the desired control board for replacement, the following table has been prepared to show the correspondence between the channel numbers and the connector designations on the master board which secure the associated control board. The power supply board is included in the listing.

TABLE 5-2. BOARD LOCATION

CHANNEL NO.	CONNECTOR DESIGNATION
1	J202
2	J203
3	J204
Power Supply Board	J201

b. Removal and replacement of the power supply board or control boards are performed through the following procedures:

(1) Remove the charger assembly from its case bottom by performing the operations outlined in paragraph 5-5.

(2) Remove the board retainer by turning the three fasteners along its length one-quarter turn in the counterclockwise direction and lifting it from its position.

(3) Carefully pull the desired board straight out from its connector and replace. See figure 5-6 and table 5-2.

5-7. REPLACEMENT OF MASTER BOARD. To remove and replace the master board, perform the following operations:

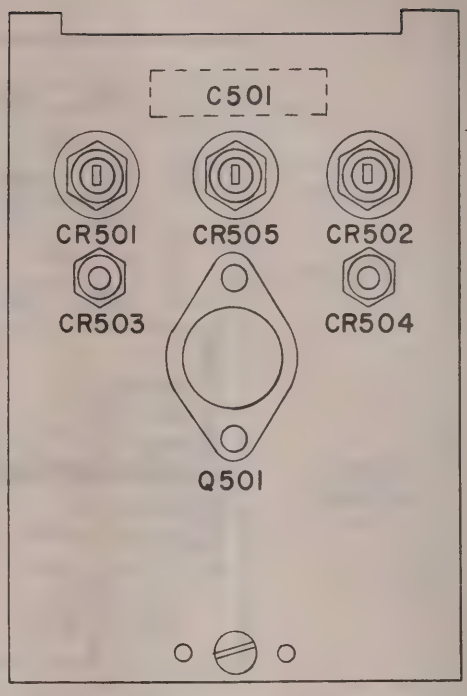


Figure 5-7. Component Locations; Heat Sink Bracket

a. Remove the charger assembly from its case bottom by performing the operations outlined in paragraph 5-5.

b. Remove the board retainer by turning the three fasteners along its length one-quarter turn in the counterclockwise direction and lifting it from its position.

c. Carefully pull the three control boards and the power supply board straight out from their connectors on the master board. See figure 5-6.

d. Unsolder all of the wires which connect to the heat sink brackets and the component side on the master board. These wires are to be unsoldered at the component end of the wire, not at the master board end. See figures 5-6, 5-7, and 5-8.

e. At the side terminal of each of the channel output fuse holders, unsolder the wire which extends across the connector side of the master board.

f. On the front panel, remove all the rotary switch knobs and all the hardware securing the rotary switches to the front panel.

g. Carefully lift the master board from its position on the front panel.

h. Remove the three heat sink brackets from the master board by unfastening the two screws which secure each bracket to the master board.

i. Removal of the master board is complete. To replace the master board, reverse the foregoing procedure.

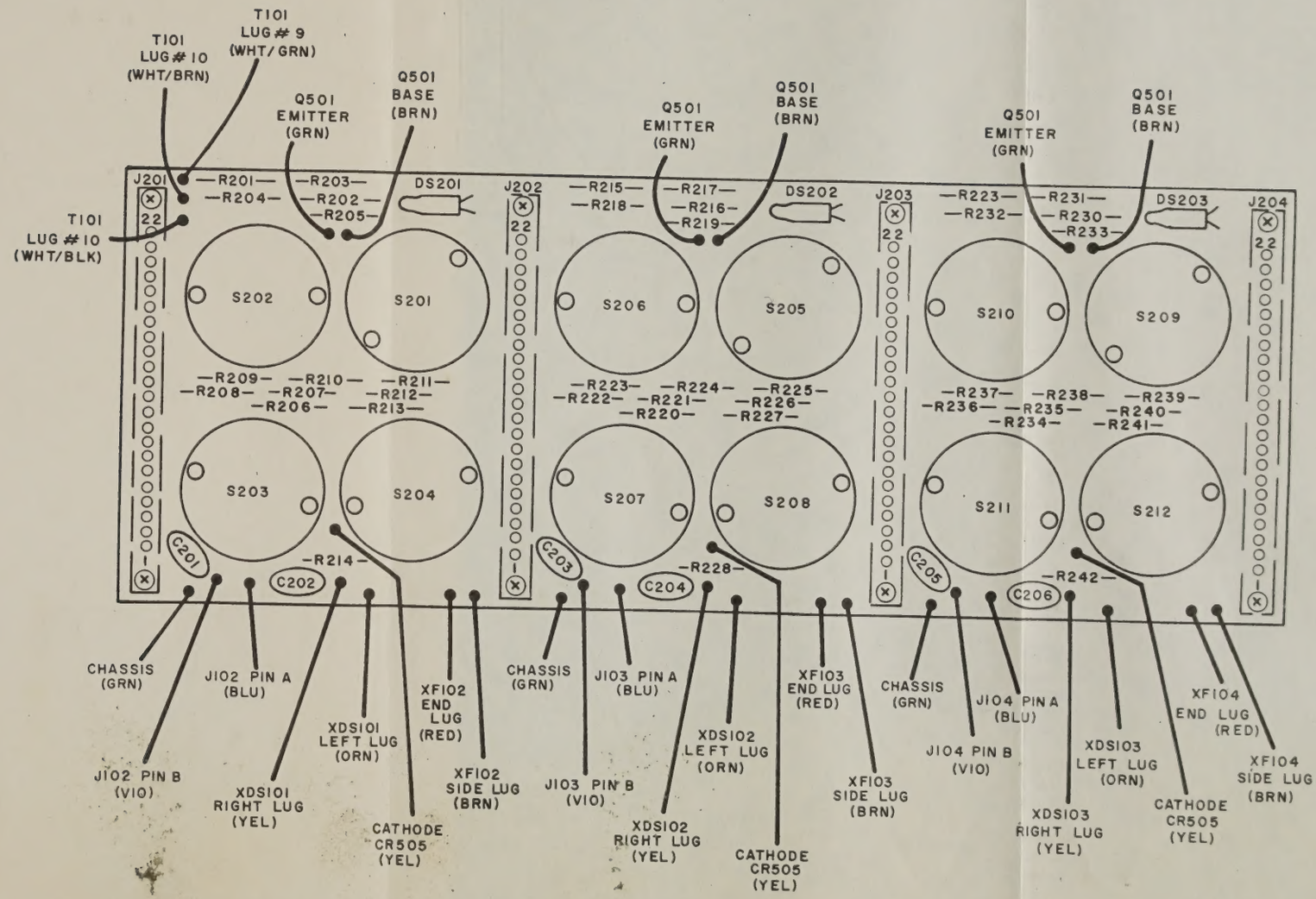


Figure 5-8. Component Locations; Master Board